IN THE SPRCIFICATION

Kindly amend pages 15-16 and 20-29 as follows:

amount of F contained in the fluoride or fluorides should be 10 - 45% in order to minimize the change in refractive index of the glass due to the compaction phenomenon. The above described oxides may be substituted by fluorides and the above described fluorides may be substituted by oxides within a range in which the ratio of metal ion, oxygen ion and fluorine ion of the respective oxides and fluorides is maintained.

Examples

Examples of the optical glass made according to the invention will now be described. Examples No. 1 to No. 24 shown in Tables 1 to 4 are examples of composition of the SiO_2-PbO-alkali metal oxide glass of the present invention. Examples No. 25 to No. ~~38~~ 32 shown in Tables 5 and 6 are examples of composition of the SiO_2-B_2O_3-alkali metal oxide and/or alkaline earth metal oxide glass of the present invention. Examples No. ~~39~~ 33 to ~~59~~ 53 shown in Tables 7 to 9 are examples of composition of the P_2O_5-Al_2O_3-alkaline earth metal fluoride glass of the present invention.

Table 10 shows comparison (Comparison I and Comparison II) between Examples No. ~~60~~ 54 to No. ~~64~~ 58 of the SiO_2-PbO-alkali meal oxide glass of the present invention and Comparative Examples No. A and No. B of the prior art glasses.

Table 11 shows comparison (Comparison III and Comparison IV) between Examples No. ~~65~~ 59 and No. ~~66~~ 60 of the SiO_2-B_2O_3-alkali metal oxide and/or alkaline earth metal oxide glass of the present invention and Comparative Examples No. C and No. D of the prior art glasses.

In Tables 1 to 11, Δn (ppm) represents an amount of change in refractive index between a state before radiation and a state after radiation in a portion where radiation of laser beam having beam diameter of 2.0mm, wavelength of 351 nm, average output power of 0.43W, pulse repetition rate of 5kHz and pulse width of 400ns has been radiated for 1 hour..

Table 12 shows Examples No. ~~67~~ 61 to No. ~~70~~ 64 of the SiO_2-PbO-alkali metal oxide glass of the present invention and Examples No. ~~71~~ 65 to No. ~~73~~ 67 of the SiO_2-B_2O_3-alakli metal oxide and/or alkaline earth metal oxide glass of the present invention. Table 13 shows change in refractive index Δn (ppm) between a state before radiation and a state after radiation in a portion where radiation of the above-mentioned laser beam (having wavelength of 351 nm and beam diameter of 2.0mm) has been made on the glasses shown in Table 12 under conditions of output and radiation time which are different from those of Tables 1 to 11.

Table 1

(mass %)

	1	2	3	4	5	6	7
SiO_2	61.390	66.000	63.000	64.800	53.200	55.880	50.200
PbO	24.800	19.890	20.200	18.500	34.600	30.200	38.200
Na_2O	9.000	6.100	6.500	9.200	6.700	6.000	5.400
K_2O	4.000	7.700	7.900	6.700	5.200	7.600	5.400
As_2O_3	0.200	0.300		0.299	0.300		0.295
Sb_2O_3			0.100			0.300	
Al_2O_3			0.400				
K_2SiF_6			1.900	0.500			
KHF_2	0.600						
TiO_2	0.010	0.010		0.001		0.020	0.005
B_2O_3							0.500
total	100.000	100.000	100.000	100.000	100.000	100.000	100.000
F	0.292		0.983	0.259			
nd	1.5481	1.5317	1.5317	1.5317	1.5814	1.5673	1.5955
ν d	45.8	49.0	49.0	49.0	40.8	42.8	39.3
Δ n(ppm)	3.1	3.2	2.0	2.5	4.9	3.9	4.7

Table 5

(mass %)

	25	26	27	[[28]]	[[29]]	[[30]]	28 ~~31~~
SiO_2	64.950	55.850	55.350	~~42.000~~	~~35.550~~	~~30.000~~	68.990
B_2O_3	14.900	13.050	6.050	~~13.600~~	~~16.000~~	~~20.000~~	11.100
Al_2O_3	2.300	0.500	0.600	~~4.200~~	~~4.500~~	~~5.500~~	
Li_2O			3.000	~~2.000~~	~~2.000~~	~~2.000~~	
Na_2O	9.250		1.200	~~0.300~~	~~0.300~~		9.550
K_2O	6.850	11.450	8.700				7.750
BaO			16.850	~~37.050~~	~~40.750~~	~~40.000~~	1.550
ZnO			5.750				1.000
PbO	1.095		2.000	–	~~0.500~~		
TiO_2	0.005	0.050		~~0.100~~			0.010
As_2O_3	0.150		0.250	~~0.400~~	~~0.400~~	~~0.300~~	
Sb_2O_3		0.010	0.250				0.050
K_2SiF_6		19.090					
KHF_2	0.500			~~0.350~~		~~0.200~~	
CaO						~~2.000~~	
Total	100.000	100.000	100.000	~~100.000~~	~~100.000~~	~~100.000~~	100.000
F	0.243	9.879		~~0.170~~		~~0.097~~	
Nd	1.5163	1.4875	1.5567	~~1.5891~~	~~1.6031~~	~~1.6056~~	1.5163
υd	64.1	70.2	58.7	~~61.2~~	~~60.6~~	~~61.1~~	64.1
Δ n (ppm)	0.7	0.0	0.5	~~0.5~~	~~0.7~~	~~0.3~~	0.0

Table 6

(mass [[5]] %)

	29 ~~32~~	30 ~~33~~	[[34]]	[[35]]	31 ~~36~~	32 ~~37~~	[[38]]
SiO_2	67.20	67.80	~~40.00~~	~~34.55~~	49.00	55.80	~~35.50~~
B_2O_3	3.60	4.10	~~12.30~~	~~18.00~~	17.90	13.05	~~16.00~~
Al_2O_3			~~4.50~~	~~5.50~~	0.30	0.50	~~4.50~~
Li_2O			~~2.00~~				~~2.00~~
Na_2O	12.50	12.10	~~0.30~~	~~0.30~~			~~0.50~~
K_2O	6.13	6.15			12.00	11.40	~~0.20~~
BaO	10.22	9.45	~~38.00~~	~~38.75~~			~~40.80~~
PbO				~~0.50~~			
TiO_2		0.20	~~0.50~~			0.04	~~0.10~~
As_2O_3	0.35		~~0.40~~	~~0.40~~	0.20	0.01	~~0.40~~
Sb_2O_3		0.20					
K_2SiF_6						19.20	
KHF_2					20.60		
SrO			~~2.00~~				
ZrO_2				~~2.00~~			
Total	100.00	100.00	~~100.00~~	~~100.00~~	100.00	100.00	~~100.00~~
F					10.02	9.94	
Nd	1.5184	1.5184	~~1.5962~~	~~1.5989~~	1.4850	1.4860	~~1.6025~~
υd	60.3	60.3	~~60.5~~	~~60.3~~	70.1	69.7	~~60.5~~
Δ n (ppm)	0.4	0.2	~~0.4~~	~~0.3~~	0.1	0.1	~~0.5~~

Table 7

(mass %)

	33 ~~39~~	34 ~~40~~	35 ~~41~~	36 ~~42~~	37 ~~43~~	38 ~~44~~	39 ~~45~~	40 ~~46~~
P_2O_5	27.45	22.45	21.05	5.55	10.85	9.35	19.40	4.85
Al_2O_3	6.55	5.35	5.05	1.35	2.60	2.20	3.95	1.15
AlF_3	7.25	11.55	12.45	24.30	24.05	28.30		27.20
MgF_2	4.45	6.05	5.10	5.20	4.25	5.30		4.05
CaF_2	11.20	15.80	16.05	25.55	20.95	16.65		20.20
SrF_2	18.00	20.35	25.85	26.10	24.00	26.75	22.00	21.55
BaF_2	25.10	18.45	14.45	11.80	13.20	10.65	44.50	15.00
YF_3								5.00
NaF					0.10			
KF				0.15				1.00
Y_2O_3							3.00	
La_2O_3							5.00	
SnO_2							0.05	
SrO						0.80	2.10	
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	23.97	29.37	30.32	42.60	39.28	40.94	16.30	42.94
Nd	1.5296	1.5043	1.5006	1.4353	1.4505	1.4541	1.5632	1.4388
υd	76.2	79.4	81.1	85.5	81.6	90.5	69.8	95.1
Δn (ppm)	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0

Table 8

(mass %)

	41 47	42 48	43 49	44 50	45 51	46 52	47 53	48 54
P_2O_5	25.00	38.20	22.60	20.00	32.15	21.50	11.70	20.15
Al_2O_3	6.00	8.60	5.40		1.80	3.30	2.80	2.55
AlF_3				10.00	7.50		26.50	13.75
MgF_2			0.50		2.35	8.00	4.00	4.90
CaF_2		9.00		10.00	7.00	15.00	14.00	15.40
SrF_2	15.00		14.00	20.00	9.20	13.00	23.00	15.85
BaF_2	28.00	22.00	47.00	20.00	25.00	22.00	12.00	15.80
YF_3		3.00						
LaF_3	5.00		2.00					
GdF_3						10.00		2.60
LiF			2.50					
Y_2O_3	10.00	5.50	6.00					
La_2O_3	10.00	6.20						
Gd_2O_3		5.00		20.00		5.00		
SnO_2	1.00							
MgO					5.00	2.20		
CaO							6.00	
SrO								9.00
BaO		2.40			10.00			
As_2O_3		0.10						
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	12.06	16.83	17.14	22.04	22.21	23.54	36.80	28.73
Nd	1.5826	1.5913	1.5583	1.5783	1.5532	1.5022	1.4565	1.4973
υd	70.3	72.6	70.6	72.0	71.2	79.2	90.1	80.9
Δ n (ppm)	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2

Table 9

(mass %)

	49 ~~55~~	50 ~~56~~	51 ~~57~~	52 ~~58~~	53 ~~59~~
P_2O_5	4.00	25.00	25.00	11.70	24.00
Al_2O_3	1.00	7.00	6.00	2.80	6.00
AlF_3	27.00			25.50	
MgF_2	5.00			4.50	2.00
CaF_2	21.00		5.00	13.50	2.00
SrF_2	21.00	15.00	15.00	22.50	13.00
BaF_2	16.00	19.00	23.00	12.50	27.00
YF_3	5.00	10.00			
LaF_3		5.00	10.00		5.00
NaF				1.00	
Y_2O_3			10.00		5.00
La_2O_3		10.00			5.00
Gd_2O_3			5.00		
Yb_2O_3					10.00
CaO				6.00	
SrO			1.00		
BaO		9.00			1.00
Total	100.00	100.00	100.00	100.00	100.00
F	37.52	29.12	14.87	36.59	13.13
Nd	1.4378	1.5816	1.5822	1.4562	1.5820
υd	97.1	70.2	69.9	90.0	70.1
Δ n (ppm)	0.1	0.1	0.2	0.1	0.1

Table 10

(mass %)

	Comparison I			Comparison II			
	54 ~~60~~	55 ~~61~~	Com. Ex. A	56 ~~62~~	57 ~~63~~	58 ~~64~~	Com. Ex. B
SiO_2	63.00	65.30	66.00	53.10	53.05	52.00	53.10
PbO	20.20	18.50	19.90	34.70	34.70	34.00	34.70
Na_2O	6.50	9.20	6.10	6.70	6.70	6.60	6.70
K_2O	7.90	6.70	7.70	5.20	5.20	5.10	5.20
As_2O_3		0.30		0.30		0.30	
Sb_2O_3	0.10		0.30		0.30		0.30
Al_2O_3	0.40						
K_2SiF_6	1.90					2.00	
TiO_2					0.05		
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	0.98					1.04	
Nd	1.5317	1.5317	1.5317	1.5786	1.5801	1.5717	1.5800
ν d	49.0	49.0	49.0	41.0	40.9	41.7	40.8
Δ n(ppm)	2.9	3.4	6.3	4.9	4.5	4.2	10.0

Table 11

(mass %)

	Comparison III		Comparison IV	
	59 ~~65~~	Com. Ex. C	60 ~~66~~	Com. Ex. D
SiO_2	67.80	67.20	68.99	64.95
B_2O_3	4.10	3.60	11.10	14.90
Al_2O_3				2.30
Na_2O	12.10	12.50	9.55	9.25
K_2O	6.15	6.13	7.75	6.85
BaO	9.45	10.22	1.55	
ZnO			1.00	
PbO				1.60
TiO_2	0.20		0.01	
Sb_2O_3	0.20	0.35	0.05	0.15
Total	100.00	100.00	100.00	100.00
Nd	1.5184	1.5184	1.5163	1.5163
ν d	60.3	60.3	64.1	64.1
Δ n(ppm)	0.2	6.0	0.0	7.0

Table 12

(mass%)

No.	61 ~~67~~	62 ~~68~~	63 ~~69~~	64 ~~70~~	65 ~~71~~	66 ~~72~~	67 ~~73~~
SiO_2	63.20	65.48	51.62	51.62	57.85	68.50	69.34
B_2O_3					13.52	3.99	11.11
PbO	20.33	20.27	34.80	34.80			
K_2O	7.96	7.79	5.35	5.35	11.85	6.00	7.76
Na_2O	6.51	6.18	6.93	6.92		11.85	9.55
Al_2O	0.37		0.20	0.20	0.50		
K_2SiF_6	1.53		1.00	1.00	16.23		
As_2O_3		0.28	0.10	0.10	0.01	0.20	0.03
Sb_2O_3	0.10						
TiO_2				0.01	0.04	0.20	0.01
BaO						9.26	1.19
ZnO							1.01
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	0.79		0.52	0.52	8.40		
nd	1.53168	1.53145	1.57904	1.57807	1.48713	1.51820	1.51593
ν d	48.9	49.0	40.9	41.0	70.2	60.3	64.1

Table 13

(mass%)

Δ n (ppm)

No.		68 ~~67~~	69 ~~68~~	70 ~~69~~	71 ~~70~~	72 ~~71~~	73 ~~72~~	74 ~~73~~
Average Output Power(W)	Time							
0.10	165hrs	0.2						
0.60	10min.	0.3						
0.60	15min.	0.3						
0.60	30min.	0.5						
0.60	1hour	0.5						
0.60	10min.		0.6					
0.60	1hour		1.1					
2.00	10min.			0.7				
1.20	15min.			1.0				
2.00	25min.			1.6				
2.00	10min.				0.5			
1.20	15min.				0.8			
2.00	25min.				1.3			
1.50	3hrs					0.0		
2.65	3hrs.						0.5	
2.65	3hrs.							0.6

As shown in Tables 1 to 12, the amount of change Δn in a period between before and after radiation of laser beam in the glasses of Examples No. 1 to No. ~~73~~ 67 is 5 ppm or below. The glasses of Examples No. ~~60~~ 54 - No. ~~66~~ 60 shown in Tables 10 and 11 all have a smaller amount of change (Δn) in a period between before and after radiation of laser beam than the prior art glasses of Comparative Examples No. A to No. D which have similar contents of SiO_2, PbO, B_2O_3, alkali metal oxide and BaO as well as similar values of nd and ν d to these Examples of the invention and, thus, show the advantageous effects of containing the fluorine ingredient and/or the titanium oxide ingredient and/or the arsenic oxide ingredient.

The glasses of the above described examples of the invention can be easily manufactured by weighing and mixing optical glass materials such as oxides, carbonates, nitrates, hydroxides, phosphates and fluorides, melting the materials at 900 - 1500℃ for about 3 hours to 10 hours in a platinum container and/or a quartz container and thereafter refining, stirring, and homogenizing the melt and cooling the melt to a predetermined temperature, and casting it in a preheated mold and annealing it.

In summing up, the optical glass of the present invention is an optical glass wherein an amount of change in refractive index (Δn: difference in refractive index between a state before radiation and a state after radiation) caused by radiation of laser beam at wavelength of 351nm having average output power of 0.43W, pulse repetition rate of 5kHz and pulse width of 400ns for one hour is 5 ppm or below..

It is also an optical glass comprising a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient. It is also a SiO_2-PbO-alkali metal oxide glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range, or a SiO_2-B_2O_3-alkali metal oxide and/or alkaline earth metal oxide glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range, or a P_2O_5-Al_2O_3-alkaline earth metal fluoride glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range. In the optical glasses of the present